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Tests of Reinforced Concrete Beams Effect of Removal of Load

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TESTS OF REINFORCED CONCRETE BEAMS

EFFECT OF REMOVAL OF LOAD

BY

SAMUEL CORNELIUS HADDEN

THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

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U N I V E R S I T Y O F I L L I N O I S

May 26, 1905

This is to certify that the following thesis prepared under the direction of Professor A. N. Talbot, Head of the Department of Municipal and Sanitary Engineering, by

SAMUAL CORNELIUS HADDEN

entitled TESTS OF REINFORCED CONCRETE BEAMS
EFFECT OF REMOVAL OF LOAD

is accepted by me as fulfilling this part of the requirements for the Degree of Bachelor of Science in Civil Engineering

Ira O Baker

Head of Department of Civil Engineering

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Tests of Reinforced Concrete Beams

Effect of Removal of Load.

The investigation herein described was undertaken as a part of a series of tests of reinforced concrete beams made in the Laboratory of Applied Mechanics at the University of Illinois by students in Civil Engineering. These tests were a part of the general tests on reinforced concrete undertaken at several Engineering Colleges under the direction of a joint committee appointed by four of the national engineering societies.

In all, nine theses were presented on the general subject "Tests of Reinforced Concrete Beams". Of these nine theses four were on closely related subjects. Mr. E. T. Renner presented a thesis on the subject, "The Effect of Release of Load; Mr. F. I. Blair on, "The Effect of Repetition; Mr. M. B. Case on, "The Effect of Retention of Load", and this thesis on "The Effect of Removal of Load". Briefly, the purpose of this investigation was to study the action of a reinforced beam, with reference to its partial return to its original position, upon removal of load.

Since this thesis is one of nine similar ones it was thought unnecessary to give, in each thesis, detailed descriptions of the materials

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employed, of the specimens made, and of the manner of testing the specimens. Accordingly, all matter of a general nature was incorporated in one thesis: that by Mr. E. T. Renner entitled, "Tests of Reinforced Concrete Beams - The Effect of Release of Load". It was thought well, however, to repeat some parts of the most important descriptions which apply to all the tests, and to give in detail descriptions of all matters relating to materials, specimens, and testing, which are peculiar to this thesis.

The following divisions will be made: I. Description of materials. II Description of Specimens. III Description of Tests. IV. Observed Data. V. Discussion of Results.

I. Description of Materials.

Stone.— The stone used was Bonbaker limestone. The sizes were such that 90% passed a 1 in. screen and 89% was retained upon a 1/4 in. screen. The analysis showed 44% of voids.

Sand.— The sand used was clean and sharp. It was passed through a 1/4 in. mesh screen before using. The sand weighed 103 lb. per cu. ft. loose and air dried. It contained 28 to 30% voids.

Cement.— All cement used consisted of a mixture of five standard brands of Portland cement. This cement was furnished by the makers and was mixed at the mills. The tensile strength for the seven day tests

was 723±12 lb. per sq. in. for neat briquettes, and 357±12 lb for briquettes of 1:3 mortar.

Concrete.— All the concrete was mixed by hand in the proportions 1:3:6 by loose volume. A moderately wet concrete was used, the amount of water added being about 9% of the total weight of the dry material. The compression strength of the concrete was 1140 lb. per sq. in. at 60 days.

Steel.— The steel used in the beams tested for this investigation was furnished by the Carnegie Steel Co. It had an elastic limit of about 34000 lb. per sq. in. It was in plain round rods, nominally 3/4 in. and 1/2 in. in diameter. This steel will be referred to as low steel.

II. Description of Specimens.

Dimensions.— All the beams had the same dimensions, viz., length 13 ft.; width 8 in.; depth 11 in. The amount and kind of reinforcement in each beam is shown in table I

Table I.
Data on Beams.

Beam No.	Amount and kind of Reinforcement.	Per cent of metal.	Age at Moving.	Age at Test.
23	4-1/2 in. ⊗ rods. Low steel	0.98	7	62
27	3-1/2 in ⊗ rods. " "	0.74	10	68
31	4-1/2 in ⊗ rods. " "	0.98	7	62
50	4-1/2 in ⊗ rods " "	0.98	7	61

Manufacture of Beams.— A detailed description of the manner of making the beams is given in Mr. Renner's Thesis.

III Description of Tests.

Beams.— The beams weighed about 1200 lb. each. They were handled as described in Bulletin No. 1 of the University of Illinois Engineering Experiment Station.

Span and Loading.— The span length for all beams was 12 ft. The load was applied equally at the third points of the span. The loads were applied at two speeds, referred to as "slowest" and "medium" speed. The slowest speed used was about .03 in. per minute, and the medium speed was about 3.3 in per minute. Several readings were taken at intervals of 1000 lb.

The load was applied and run up to a certain point, in two cases 6000 lb, in one 5000 lb., and in the other 2000 lb., and then removed. The stress in the steel produced by these loads did not exceed the elastic limit of the metal. After the load was removed readings were taken at intervals to determine whether or not the beam was returning to its original position. Further, it was the purpose of the investigator to determine how much permanent set was left in beam after a considerable lapse of time, and to observe at what time of the test the partial return took place, that is, whether the return took place shortly after the load was removed or at a

considerable period after the removal of the load. The time the beam was kept at rest varied from 13 hr. to 41 hr. 15 min. In the early stages of each rest period the readings were taken at about 15 minute intervals; in the latter stages of the rest period the readings were taken at intervals varying from one to four hours. Each time the beam was inspected the figures from which the deformations were calculated were read from the dials, and the center deflections were also read.

Deformations.— The figures from which the deformations in the upper fiber and in the steel were subsequently calculated were read from a set of extensometers. These instruments are fully described in Mr. Lemon's thesis. In every case the gauge length of the extensometer was 12 in., and in all cases the upper contact points were 1/2 in. below the top of the beam, and the lower contact points were placed opposite the center of the steel rods.

Deflections.— The center deflections were read by two different methods, (1) by means of a thread, and (2) by means of a cathetometer. The thread was stretched by a constant tension between two points five inches below the top of the beam at points opposite a scale fastened to the beam at the center. The scale was provided with a mirror so that the scale could be read accurately by lining up the thread and its reflection in the mirror. The thread

method was used on all the beams.

The cathetometer was used on all the beams except No. 23. So much more accurate readings could be obtained with it than with the thread that the readings of the former were given the preference. The cathetometer cross-hair was set on a fine point in a piece of paper attached to the beam at the center of the span. After the introduction of the cathetometer method the thread method served only as a rough check.

IV Observed Data.

In tables II to V, pages 20 to 28, are given the original readings taken for each beam; and on Plates 1 to 4 pages 16 to 19, are given the diagrams of deformations, deflections, and position of neutral axis. Below is given the general notes concerning the test of each beam.

Beam No. 23. - This beam was apparently in good condition at the beginning of the test. Loads were applied in increments of 1000 lb. until 6000 lb. was reached. No cracks were noted at this load. Then the load was removed 1000 lb. at a time until the load was all off. After taking some readings at time intervals to note the effect of rest, shown in table II, the load was applied 1000 lb. at a time until 9000 lb. was reached. At 9000 lb. the first crack appeared. This crack is designated as crack A in Figure 1. Crack A was 11 in. inside of the North load, and extended from the bottom to within 1½ in. of top.

The load was removed 1000 lb. at a time, and then again run up to 9000 lb. with varying increments and removed in same way. The load was then run continuously from 0 lb. to 9000 lb. at 9000 lb. a new crack appeared. This crack will be designated as crack B. It was 23 in. outside of the North load, and extended to within 8 1/2 in. of the top of the beam. The load was then removed without any intermediate stops. The test to destruction then commenced with increments of 1,000 lb. at 9000 lb. several fine cracks appeared at the bottom of the beam outside of the middle third. at 11000 lb. crack A extended to within 8 in. of the top of the beam. at 12000 lb. this crack was only 5 in. from the top of the beam, and had opened 1/8 in. The maximum load was 12800 lb. The load fell away rapidly and no readings were obtained at the maximum. The loads decreased steadily beyond the maximum. at 11200 lb. the top began to buckle. at 11320 lb. crack A was within 3 in. of top of beam. The test ended with a reading at 12500 lb. At this point the beam had deflected 2.22 in. and had crushed down 1 1/2 in. from top. The crack was vertical. This beam failed in tension.

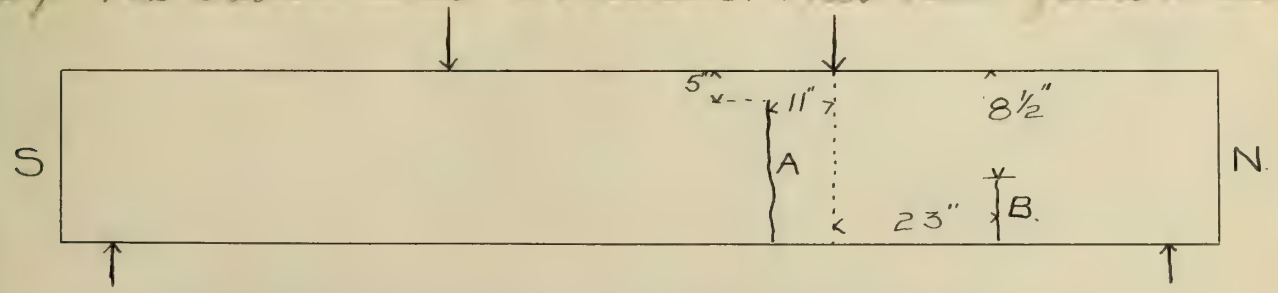


Fig. 1. Beam No. 23 at Maximum Load

Beam No. 27.— This beam was unsigned by the accident to the beams in storage. It was reinforced with 3-½ in round rods while the others described here had 4-½ in. rods. Loads were applied on No. 27 in 1000 lb. increments until 6000 lb. was reached. At 5000 lb. two cracks appeared, one, crack A, being 10 in. outside the North load on the West side, and the other, crack B, was 2 in. outside of the S. load on the West side. At 6000 lb. another crack, which will be referred to as crack C, appeared in the middle of the beam 5 in. S. of the center, on the W. side. The load was removed 1000 lb. at a time. Observations on the effect of rest were made at times shown in table III. Forty one and one quarter hours after the removal of the load the load was re-applied 1000 lb. at a time until the specimen failed. At 8000 lb. a new crack appeared 1½ in. inside the S. extensometer yoke on the E. side. This crack will be referred to as crack D. At 8000 lb. this crack was within 5 in. of top. This was the maximum load and the beam began to buckle at the top. The loads decreased beyond the maximum. At 7650 lb. the crack was within 3 in. of the top and was ¼ in. wide at the bottom. All cracks on W. side except D

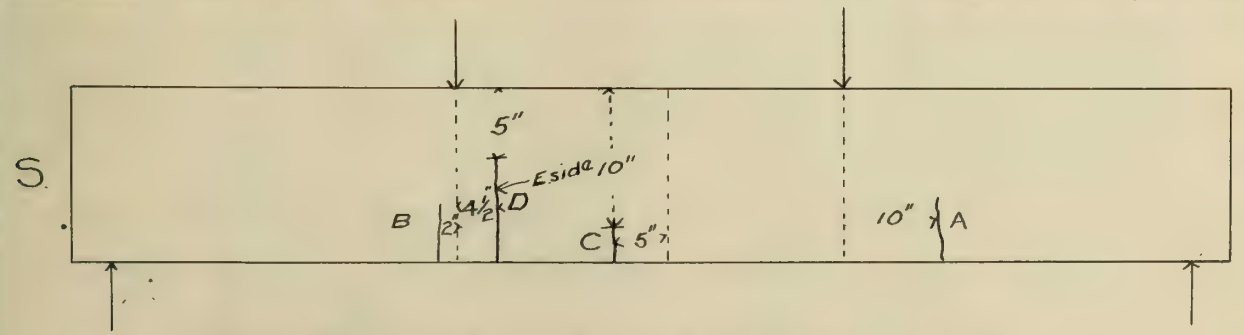


Fig. 2. Beam No. 27 at Maximum Load.

Beam No. 31.- This beam was cracked clear across when the beams overturned in storage. The crack was 5 in. outside the S. one-third point as the beam was placed on the table of the machine. No other cracks appeared during the test. Table No. IV shows how the loads were applied. The crack in the beam was vertical.

Beam No. 50.- This beam was in perfect condition. It was loaded up to 2000 lb. and then the load was removed, and the effect of rest observed. The extensometer readings were noticed to fluctuate so some tests were made to determine the effect of temperature on the readings. Table No. V shows the result of these tests. This matter of temperature is further taken up under the discussion of Beam No. 50 page . The beam was removed from the machine apparently in as good condition as at the beginning of the test, no cracks having appeared.

V. Discussion of Results.

It was known, before this series of tests was made, that a reinforced concrete beam that had been deflected under a load, retained a set at the time of the removal of load even though the elastic limit of the steel had not been exceeded. In this investigation it was the purpose to determine whether the beam would partly return to its original position within a period of ten to forty hours after the removal of load. If such a return took place it was also desired to know whether the return took place

early or late in the period of rest.

Beam No. 23.— An inspection of the table of original readings and the curves for this beam will show that within a period of 13 hr. this beam returned .02 in. toward its original position. Further, it will be noticed, .01 in. of the return took place within 1 hr. 30 min., and that the remaining .01 in of return took place in the following 4 hr. 30 min. The total return of this beam, then, was 25%. It should be remembered, however, that these deflections were read by the thread method only.

Before the rest test was made the largest load applied was 6000 lb. This stress produced a unit elongation in the steel of .000597 in. Using the value of the coefficient of elasticity as 30 000 000, we have, from the known relation that the coefficient of elasticity is equal to the unit stress divided by the unit deformation, the unit stress in the steel equals $30{,}000{,}000 \times .000597 = 17900$ lb. This stress may be computed in another way, viz., by equating the bending moment to the resisting moment. Or

$$\tfrac{1}{6} W l = a \times S \times d\left(1 - \tfrac{4}{11} K\right) \qquad (1.)$$

where W = load in pounds on beam.
l = length of span in inches = 144 in
a = area of steel
S = stress in steel
d = effective depth of beam = 10 in.
K = ratio of distance from top of beam to neutral axis to effective depth of beam.

Substituting in equation (1) S = 22150 lb. Both methods show the stress in the steel, before the rest test was made, to have been well below the elastic limit 34000 lb.

Beam No. 27.— An inspection of the table of original readings and of the curves for beam No. 27 will show that for a period of 20 hr 15 min. after the removal of the load no return took place, but that in the next 5 hr. 30 min. there was a return of .03 centimeters (.012 in.) In an additional period of 18 hr there was no apparent further return. The original set was .126 in. The return was .012 a per cent of 9.5 of the original set. On this beam the deflections were read by means of the cathetometer and the setting of the cathetometer was checked on the rest tests by at least two observers.

The maximum load applied before the rest test was 6000 lb. This produced a unit elongation of .000949 in. Figuring by the first method used for beam No. 23, this gives a unit stress of 28710 lb. The second method gives 28900 lb.

Beam No. 31.— This beam was broken as noted before. Under the rest test in a period of 15 hr. 15 min. it did not show any return toward its original position. The maximum unit stress developed before the rest test was that due to the 8000 lb. load. This stress was 26700 lb. computed by the first method, and 29000 lb. computed by the second method. The original set was .173 in.

Beam No. 50.— Beam No. 50 was loaded to

2000 lb. only. This load was removed and the effect of rest was observed. In a period of 3 hr. no return could be detected. In an additional period of 12 hr. the beam returned .04 centimeters (.016 in.) The remaining time on this beam was on the machine was devoted to determining the variation in extensometer readings due to changes in temperature.

While observing the effect of rest it was noticed that the extensometer readings fluctuated. It was noticed, further, that one pair of dials, that is, the upper and lower dials almost always changed in the same manner. For example, if the reading on dial No. 1 increased there was usually a similar increase on dial No. 3. The pair No. 2 and No. 4 behaved in the same way. It was thought that these changes were probably due to temperature variations, affecting the length of the brass rods of the extensometer. Since the graduations on the upper dial increased in a clockwise direction and those on the lower dial in a counter-clockwise direction it is evident that a change of length of the bars will cause one reading to increase and the other to decrease. Moreover, if the rods were equally exposed, the increase of reading on one dial should equal the decrease of reading on the other. In many cases, as the tables show, this was exactly what happened, and in all cases the increase and decrease were very nearly equal. It is safe to conclude that

variations in temperature affect the extensometer readings taken during the rest tests.

Table V shows that between 12 and 1:10 P.M., May 12, there was a rise of one degree in temperature. The table also shows that the readings on the upper dials I and III each increased by .0005 in., and that the lower dials II and IV lost .0006 in. and .0005 in. respectively. Since this confirms very nearly with the theory that increase should equal decrease, and since at that time of day all four extensometer rods were equally exposed to the sunlight, the writer thinks that 1 degree rise in temperature will change the dial readings .0005 in. In a test where the loads are applied continuously the temperature effect is quite negligible. Since the conclusions in this thesis are based on the center deflections alone these temperature effects may be disregarded here also.

Conclusions.

It will be remembered that beam No. 23 returned .01 in. in the first hour and a half of the rest period. The writer considers it very likely that personal bias entered into the reading of the first deflection during the rest test on this beam. This was the first beam tested. The observer was looking for a return of the beam, and as only the thread method of reading deflections was used, it is probable that he anticipated the return. In all other cases, however, the deflections were read with an accurate instrum-

ment hence the results obtained for the other beams are above question. Another reason for believing that the first reading in the case of beam No. 23 was influenced by bias is the opposite action of the other beams. Beam No. 27 showed no return in 20 hr. 15 min., No. 31 showed no return in 15 hr. 15 min., and No. 50 showed no return in 3 hr., the next reading being 12 hr. later.

If all the beams tested it seems most reasonable to suppose that beam No. 50 would have been most likely to show an early return since the load applied was only 2 000 lb. However, there was no return in 3 hr. Twelve hours later the beam had returned .04 centimetre. This was within .03 centimetre of the beam's original position. It does not seem unreasonable to suppose that had the period of rest been extended still further return might have taken place in all the beams.

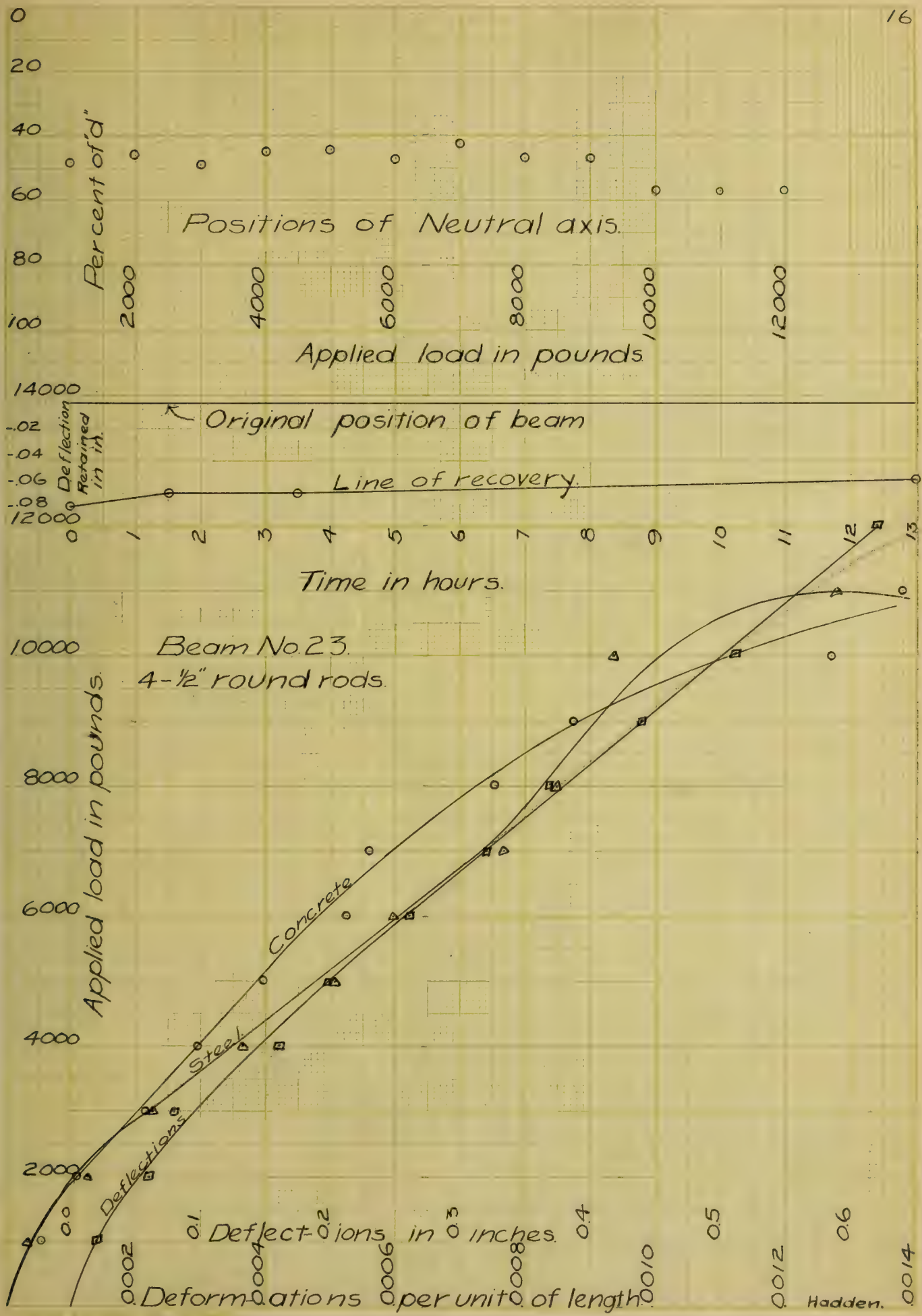
I conclude that the return takes place gradually from the time the load is removed until the beam finally comes to rest. Very likely in the intervals of rest for which no return was recorded the return later recorded was accumulating but had not grown large enough to be certainly detected. The writer believes there is room for further experimenting along this same line. It would not be well to extend the period of rest until it seems certain that the beam has actually come to rest.

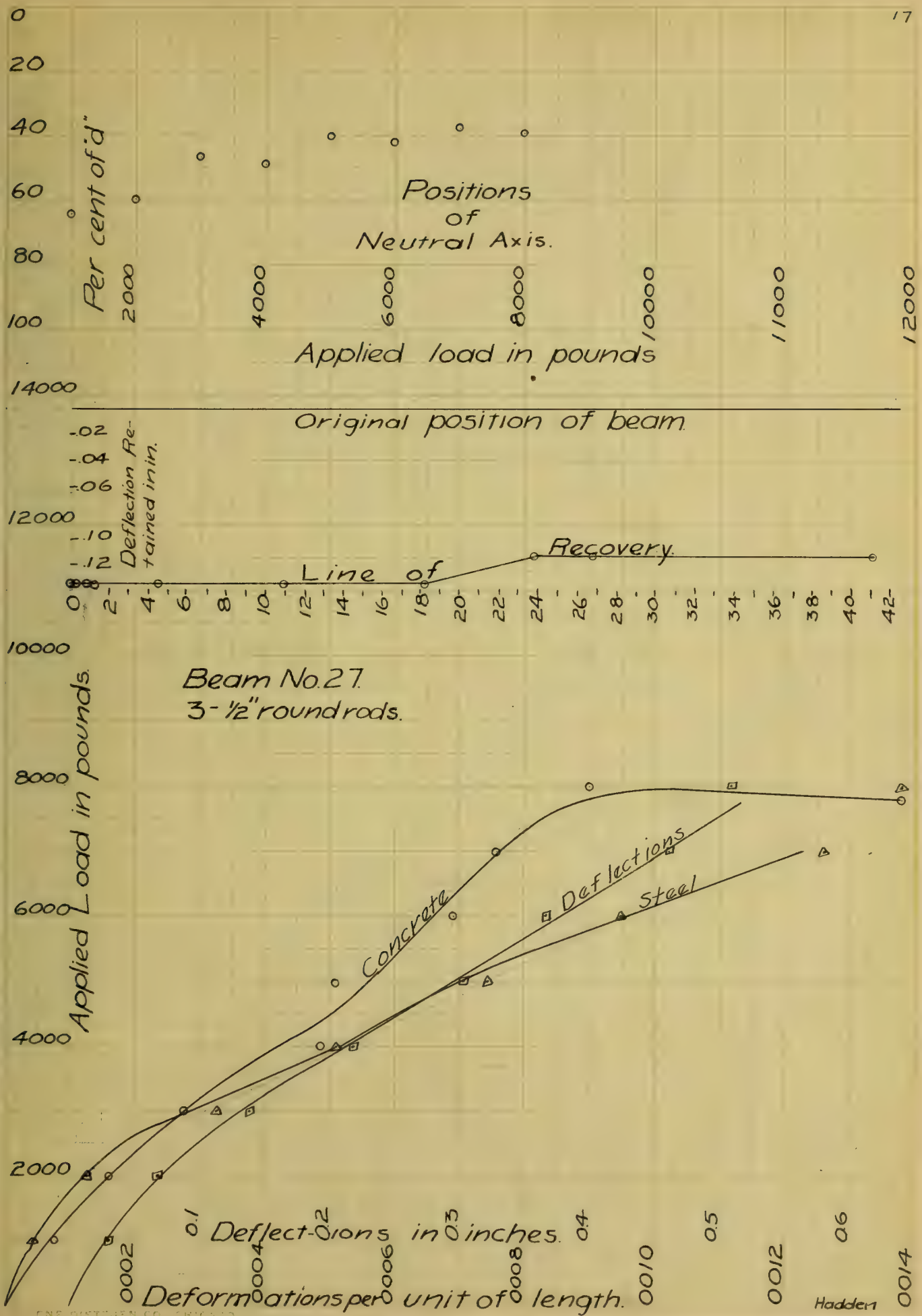
The following table presents a summary of the time tests:

Table II.

Beam No.	Period of Rest. hr.	stress in steel in % of Elastic limit.	Return in % of Original Set.
23	13	65.1	25.0
27	41¼	85.0	3.5
31	15¼	85.3 Broken	0.0
50	38 5/6	17.1	57.1

Finally the writer concludes that the amount of return is proportional to the load applied, when the stress in the steel does not exceed the elastic limit. Further, the writer believes that the return takes place gradually from the time the load is removed until the beam finally comes to rest.


Percent of "d"
Positions of Neutral axis.
Applied load in pounds
Original position of beam
Deflection Retained in in.
Line of recovery.
Time in hours.
Beam No. 23.
4-½" round rods.
Applied load in pounds.
Concrete
Steel
Deflections
Deflections in inches.
Deformations per unit of length.
Hadden.



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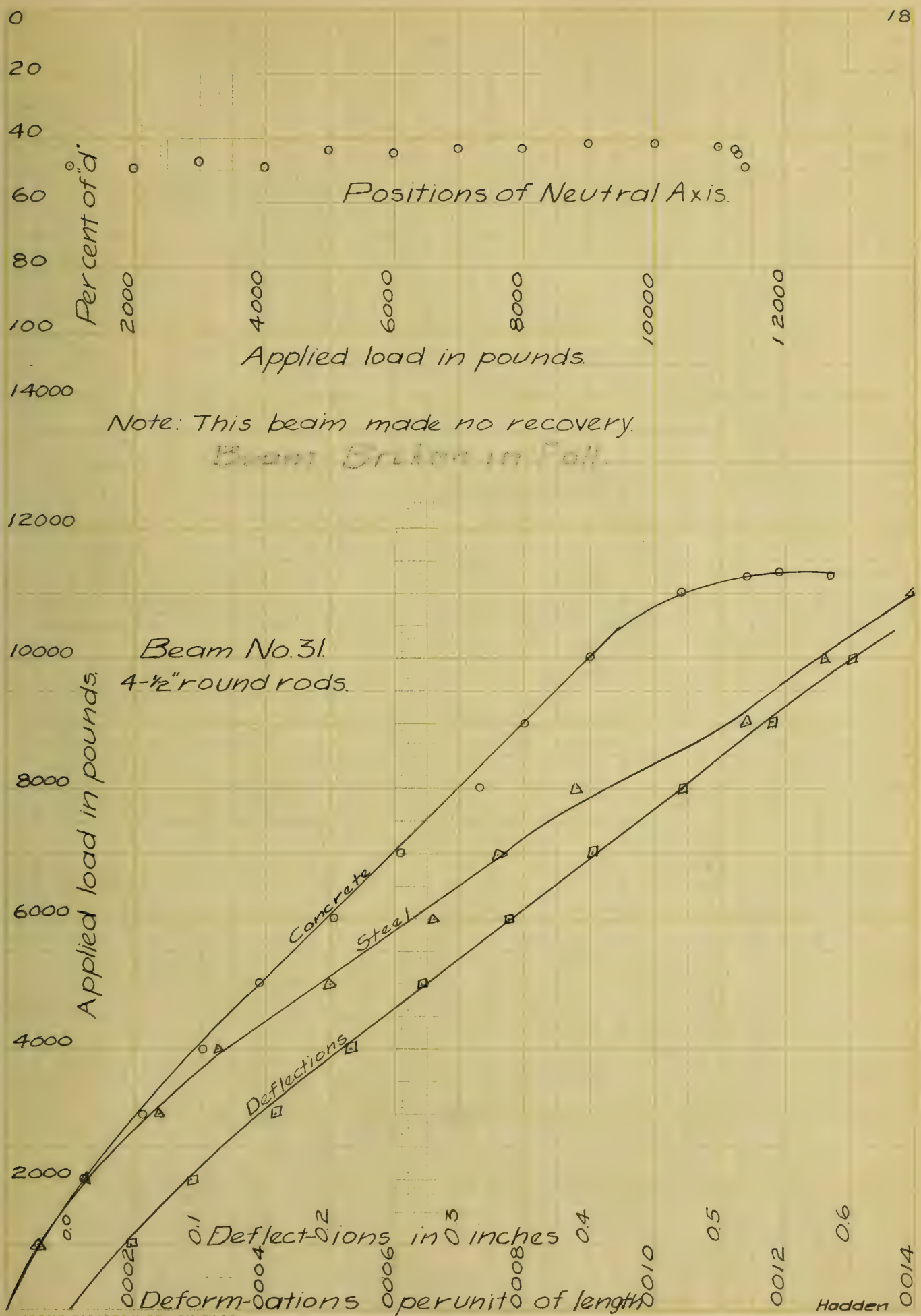

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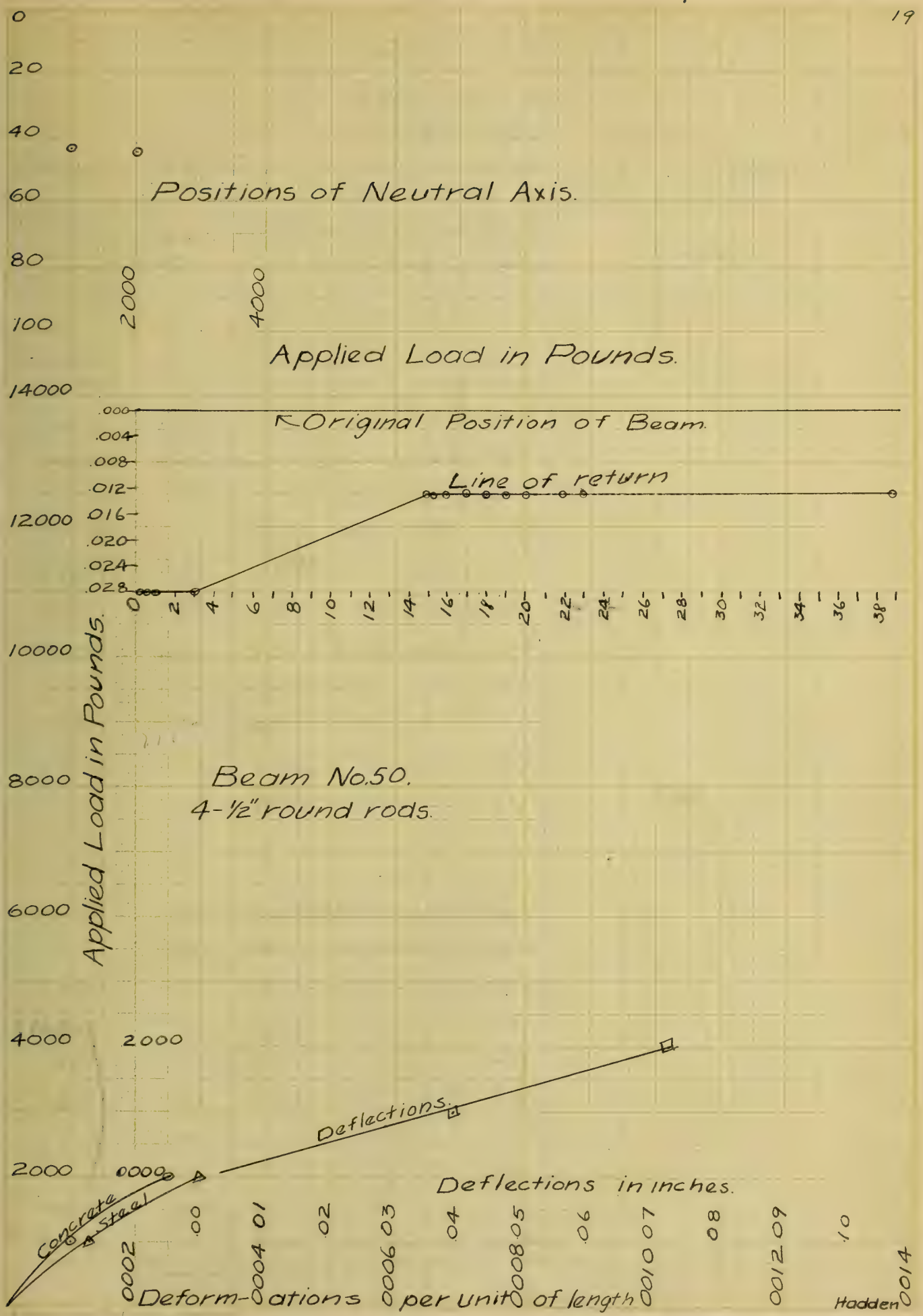
Positions of Neutral Axis.
Applied Load in Pounds.
Original Position of Beam.
Line of return
Applied Load in Pounds.
Beam No.50.
4-½" round rods.
Deflections.
Deflections in inches.
Concrete
Steel
Deform-ations per unit of length
Hadden

Beam No. 23.
Reinforced with
4-½" O rods.

Beam 8"×11"×13'-0" 62 days old. Span 12'

Applied Load lb.	Deflection in.	Extensometer Readings				Remarks.
		I	II	III	IV	
0	1.34	.2566	.0229	.0236	.0181	
1900	1.36	2610	269	271	221	
2000	1.40	2672	337	315	288	
3000	1.42	2746	428	400	383	
4000	1.50	2828	536	485	498	
5000	1.54	2917	653	575	617	
6000	1.60	3015	713	674	737	
6000	1.60	1185	977	932	1121	
5000	1.60	1157	940	905	1080	
4000	1.56	1104	875	852	1014	
3000	1.52	1050	811	798	945	
2000	1.50	0997	744	744	875	
1000	1.47	922	658	682	795	
0	1.42	844	570	620	718	
0	1.41	—	—	—	—	
0	1.41	—	—	—	—	
0	1.40	.0810	0564	0601	0713	
0	1.40	.0211	0229	0282	0205	
1000	1.43	0258	0287	0331	0269	
2000	1.47	321	359	389	342	
3000	1.50	386	432	451	419	
4000	1.54	449	502	513	490	
5000	1.58	510	582	577	564	
6000	1.61	574	650	641	646	
7000	1.66	651	737	719	740	
8000	1.71	734	834	806	844	

Beam No. 23. Continued

Applied Load lb.	Deflection in.	Extensometer Readings				Remarks.
		I	II	III	IV	
9000	1.77	.0832	.0943	.0907	0959	
9000	1.77	797	880	957	768	
8000	1.75	779	848	935	732	
7000	1.72	729	788	885	668	
6000	1.69	669	713	834	587	
5000	1.64	609	643	767	512	
4000	1.62	544	573	704	427	
3000	1.58	477	485	642	345	
2000	1.53	402	398	568	249	
1000	1.50	324	312	502	167	
0	1.45	244	222	424	075	
0	1.45	226	274	223	224	
1000	1.48	279	332	269	279	
2000	1.51	342	412	339	358	
3000	1.55	417	494	397	445	
6000	1.67	621	733	594	698	
8000	1.74	746	888	720	859	
9000	1.80	814	972	791	947	
9000	1.80	792	860	904	799	
8000	1.77	759	818	867	752	
7000	1.73	710	755	817	687	
3000	1.60	448	440	565	353	
2000	1.54	377	358	493	262	
1000	1.50	296	267	424	174	
0	1.45	210	175	350	088	
0	1.45	205	193	287	109	
9000	1.80	800	888	863	837	

Beam No. 23 Continued.

Applied Load lb.	Deflection in.	Extensometer Readings				Remarks.
		I	II	III	IV	
9000	1.80	0798	0836	0873	0783	
0	1.45	191	144	304	060	
0	1.45	154	168	178	043	
1000	1.49	203	227	226	101	
2000	1.53	297	333	311	206	
3000	1.57	349	397	364	272	
4000	1.61	419	478	431	358	
5000	1.64	489	563	501	448	
6000	1.69	558	644	569	535	
7000	1.72	622	722	634	617	
8000	1.76	685	798	698	698	
9000	1.81	752	875	765	777	
10000	1.85	825	969	838	865	
11000	1.90	916	1059	931	970	
12000	1.96	1028	1183	1047	1089	
12800						
11400	2.11	1382	1797	1412	1732	
11300	2.23	1686	2385	1720	2258	
11200	2.30	1815	2558	1854	2479	
11270	2.42	2131	3025	2192	3034	
11100	2.57	2517	3735	2608	3688	
11030	2.70					
11050	2.81	3138	4764	3234	4721	
10700	2.92	3446	5245	3560	5230	
10700	3.12	4016	6087	4130	6094	
10500	3.56	5400	7720	5550	6275	

Beam No. 27.

Reinforced with
3-½ o rods

Beam 8"×11"×13'-0" 68 days old. Span 12'

Applied Load lb.	Deflection centi-meters	Deflection in	Extensometer Readings I	II	III	IV	Remarks
0	8723	220	.0000	.0000	.0000	.0000	
1000	8716	222	0045	0038	0064	.0057	
2000	8706	225	113	114	135	0136	
3000	8688	231	231	273	241	292	
4000	8664	239	355	449	450	463	
5000	8646	245	473	614	456	624	
6000	8630	252	598	781	632	789	
5000	8634	250	568	738	534	734	
4000	8643	246	506	660	475	652	
3000	8653	243	438	573	410	561	
2000	8665	239	365	481	458	467	
1000	8677	233	276	371	266	359	
0	8691	230	195	261	180	248	
0	8691	230	188	258	172	239	
0	8691	230	187	258	172	238	
0	8691	230	187	255	172	238	
0	8691	230	185	255	174	236	
0	8691	230	177	264	162	239	
0	8691	230	171	270	157	247	
0	8694	230	169	279	154	258	
0	8694	230	179	272	167	248	
0	8694	230	180	277	169	244	
0	8694	230	173	284	161	255	
0	8694	230	.0000	.0000	.0000	.0000	

Beam No. 27 Continued.

Applied Load lb	Deflection		Extensometer Readings				Remarks.
	Centimeter	in.	I	II	III	IV	
1000	8683	233	0069	0085	0073	0092	
2000	8673	239	148	186	144	192	
3000	8659	242	224	285	216	291	
4000	8648	247	299	381	289	288	
5000	8636	252	378	483	363	492	
6000	8622	256	464	594	443	604	
7000	8606	262	577	740	549	752	
8000	8592	269	679	834	653	877	
7800	8492	307	1530	2737	1500	2831	
7650	8364	354	2669	5118	2619	5222	

Beam No. 31.

Reinforced with
4-½" 0 rods
62 days old.

Beam 8"×11"×13'-0"

Span 12'

Applied Load lb.	Deflection. Centimeter.	Deflection. in	Extensometer Readings. I	II	III	IV	Remarks:
0	88.53		.0179	0214	0216	0222	
1000	88.41		221	258	254	275	
2000	88.29		284	330	308	335	
3000	88.13		367	434	382	424	
4000	87.98	2.94	454	543	459	473	
5000	87.84	3.00	543	659	543	629	
6000	87.67	3.06	635	774	631	735	
7000	87.51	3.12	728	889	719	839	
8000	87.33	3.19	826	1009	812	946	
8000	87.33	3.19	978	1055	940	944	
7000	8733	319	954	1030	918	922	
6000	8743	315	856	969	872	862	
4800	8756	311	842	881	810	783	
4000	8762	307	802	827	774	735	
3000	8772	303	742	752	710	600	
2000	8783	300	679	678	644	586	
1000	8795	296	607	596	584	510	
0	8809	291	530	506	514	439	
0	8809	291	522	500	508	436	
0	8809	291	521	499	507	435	
0	8809	291	521	498	507	435	
0	8809	291	518	498	504	437	
0	8809	291	517	498	503	437	
0	8809	291	510	504	495	441	

Beam No. 31-Continued.

Applied Load lb	Deflection		Extensometer Readings				Remarks
	Centi-meter	in.	I	II	III	IV	
0	88.09	2.91	0501	0509	0488	0449	
0	8809	2.91	495	506	490	448	
0	8809	2.91	155	107	151	158	
1000	88.01	2.96	209	167	197	214	
2000	87.90	3.00	279	251	262	281	
2500	87.74	3.06	372	320	306	388	
4000	87.69	3.08	470	364	340	428	
5000	87.60	311	415	435	396	495	
6000	8750	314	528	514	455	567	
7000	8738	320	599	604	524	650	
8000	8728	322	654	673	578	716	
9000	8716	327	730	771	655	805	
10000	87.00	3.32	818	872	741	911	
11000	8659	3.50	940	1020	859	1027	
11250	8620	3.67	1004	1074	924	1072	
11300	8559	385	1050	1103	960	1103	
11250	8504	410	1128	1153	1044	1133	
11400	8463	427	1215	1200	1153	1175	

Beam No. 50.
Reinforced with 4-½" ⌀ rods.

Beam 8"×11"×13'-0" — 61 days old. — Span 12'

Applied Load lb.	Deflections		Extensometer Readings				Temperature.	Time.
	Centimeters	in.	I.	II.	III.	IV.		
0	86.21	2.44	.0000	.0000	.0000	.0000		
1000	86.11	2.49	.0040	.0055	.0049	.0055		
2000	86.03	2.52	.0108	.0134	.100	.121		
1000	86.08	2.50	.0065	.0105	.071	.092		
0	86.14	2.47	.0009	.0045	.0023	.0050		5 P.M.
0	86.14	2.47	.0006	.0045	.0023	.0049		5:15
0	86.14	2.47	.0005	.0045	.0023	.0049		5:30
0	86.14	2.47	.0016	.0036	.0037	.0038		6:05
0	86.14	2.47	.0017	.0036	.0038	.0038		8:00 May 12.
0	86.18	2.47	.0004	.0056	.0025	.0059		8:00 A.M.
0	86.18	2.47	.0002	(1)	.0024	.0062	69°	8:20
0	86.18	2.47	-.0003	.0005	.0019	.0068	67°	9:00
0	86.09(2)	2.47	-.0003	.0002	.0023	.0065	66½	10.00
0	86.09	2.47	+.0005	-.0007	.0031	.0056	68-	11:00
0	86.09	2.47	.0007	-.0009	.0033	.0054	68	12:00 P.M.
0	86.09	2.47	.0012	-.0015	.0038	.0049	69	1:10
0	86.09	2.47	.0015	-.0027	.0041	.0048	70 (3)	3:00
0	86.09	2.47	.0016	-.0029	.0044	.0047	70	4:00 May 13.
0	86.09	2.47	.0014	-.0014	.0042	.0051	67	7:50 A.M.

(1) The janitor, while sweeping, knocked this extensometer rod off. The rod was replaced and the dial set at 0. The subsequent readings are of value only in determining the effect on the extensometer readings of variations in temperature.

(2) Evidently the instrument must have been disturbed since the beam would hardly deflect .09 centimeters under its own weight in an hour.

(3) Dials II and III were on the sunny side of the beam.

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